

ELEVATION OF THE SEEDBUG *EREMOCORIS BOREALIS* (DALLAS) FROM SYNONYMY WITH *EREMOCORIS FERUS* (SAY) (HEMIPTERA: LYGAEIDAE)¹

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ABSTRACT: A neotype is selected for *Eremocoris ferus* (Say) and *Eremocoris borealis* (Dallas) is raised from synonymy. These sibling species show behavioral and reproductive isolation in mating trials. The courtship behavior of *E. borealis* is described. *E. borealis* has a more northern distribution; *E. ferus*, a more southern distribution. In the zone of sympatry in southern New England the species exhibit ecological displacement in which *borealis* is restricted to cool hemlock forests, *ferus* to warmer deciduous forest. The species are morphologically distinguished. A key to the species of *Eremocoris* of North America east of the 100° meridian is given.

DESCRIPTORS: Hemiptera, *Eremocoris*, reproduction, ecology, behavior, sibling species, seedbugs.

Eremocoris is a moderately large genus of seedbugs of which 17 species and 5 "varieties" are Palearctic and 11 species are Nearctic (Slater 1964). In terms of the world fauna the genus has never been monographed and badly needs revisional study. Many new taxa are present in the western Nearctic fauna and a suspiciously large gap exists in records of *Eremocoris* from the eastern Palearctic. Nevertheless, due to the studies of Barber (1928) the fauna of eastern North America on the alpha taxonomy level is comparatively well known, and at present consists of one widespread species, *E. ferus* (Say) and two southeastern species, *E. setosis* Blatchley and *E. depressus* Barber.

Eremocoris seedbugs are common insects in eastern North America (Sweet 1964). Their apparent rarity, such as indicated by the few records given in the Slater catalogue (1964), is merely a function of the collecting habits and specializations of entomologists since the insects live on the ground under litter where, in the sense of Janzen (1971) they prey on fallen seeds, especially those of coniferous trees. I found other species of the genus in the western United States to be similarly abundant under various coniferous trees. From the standpoint of reproductive ecology and forestry the significance of these insects must be severely underestimated since the bugs not only feed on seeds after they have fallen, but do so in an inconspicuous manner through drilling a nearly invisible hole into seeds, rather than in the easily detected destructive manner of small rodents.

¹ Accepted for publication: February 7, 1977

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My study (1964) of *Eremocoris ferus* in New England suggested that actually two closely related sibling or better, cryptic species were present. Such hemipterists as Barber (1928) Blatchley, (1926) Torre-Bueno (1946), Van Duzee (1921), and Walley (1934) who had occasion to collect and study *Eremocoris* taxonomically did not distinguish these two common species.

Since names are already available for each of the species I prefer here only to differentiate the species since appropriate redescriptions ought to be made in the context of a world revision with complete series of all the available species in the genus. A key to the species of eastern North America is given. As it will be probably some time before a generic revision will be undertaken, and as both species are abundant and of some ecologic and probable economic importance, I give evidence here for the following taxonomic actions: 1) to raise *Eremocoris borealis* (Dallas, 1852) from synonymy with *E. ferus* (Say); and 2) to designate a neotype for *Eremocoris ferus* (Say, 1831).

The materials and methods used in the present study are described in Sweet (1964). Since seedbugs can be cultured and studied easily in the laboratory, reproductive as well as ecological and morphological criteria could be utilized which is unusual in taxonomic studies.

Results and Discussion

Reproductive isolation — The initial realization that two species were present came through laboratory studies. When measuring the pre-reproductive periods of *E. ferus* I noted that on several occasions normal courtship behavior, copulation, egg deposition or development did not occur (Sweet, 1964). Reexamination of the data showed that this occurred when males from hemlock-birch forests of northern New England were placed with austral New England virgin females reared in the laboratory. I could later reinvestigate these findings. An *E. borealis* sample was collected under a gray birch-jack pine association in Sparta, Wisconsin and the *E. ferus* sample was collected under *Thuja* in east central Texas at College Station. No courtship behavior was seen in paired and multiple mating trials using both virgin and mated females. The specimens used were sexually active as shown by the eliciting of normal courting behavior in *ferus* males introduced to the virgin *ferus* females. Similarly, the *E. borealis* males were placed with *E. borealis* females and went readily into the courtship behavior which was similar to that described for *E. ferus* (Sweet, 1964), except that the motions were slower and males less responsive to the females. The courtship behavior of *E. borealis* is as follows: On contact with the female the male rose slightly up on his legs and touched the female with antennae. The male would bend his antennae and stiffly hold the terminal three antennal segments at right angles

level to his body. The antennae were vibrated in rapid bursts as the male jerkily advanced toward and upon the female. This behavior was observed repeatedly since many such advances were made before copulation would occur. In the presence of an *E. ferus* female the *borealis* male extended the antennae as previously but did not respond further. *E. ferus* male behaved similarly toward an *E. borealis* female. This lack of courtship response by the males of *Eremocoris* to females of another species is in marked contrast to *Ligyrocoris* seedbugs (Sweet, 1963, Sweet, unpublished) in which males of 6 species each indiscriminately responded to the females of all the other species, and the isolating mechanism evidently was the female's escape response.

Because one of the females in the New England study did lay 65 eggs of which 23 developed and hatched but died as early instars, three virgin receptive *ferus* females and four *borealis* males were left together in a culture dish for two months during which the three virgin *ferus* females laid a total of but 11 infertile eggs. In contrast, in control cultures of *E. borealis* from Wisconsin and New Hampshire, and of *E. ferus* from Texas and Connecticut, a female normally laid hundreds of fertile eggs which hatched and were reared easily to the adult stage. Because of the logistics of my residence in Texas, the cross matings could not be further replicated and virgin *E. borealis* females were not available to mate with *E. ferus* males for the reverse cross. Nevertheless, from my experience of rearing and mating lygaeid bugs, this was strong evidence in conjunction with the ecological and morphological evidence that *E. borealis* Dallas is a distinct species from *E. ferus* Say, and is not a subspecies or an ecophenotype.

Habitat ecology.—The presence of two species made explicable my field studies in New England which showed *E. ferus* in the sense as previously understood, to have an unusually broad ecological amplitude ranging from cool wet alpine habitats on Mt. Washington, New Hampshire, to relatively dry warm *Myrica-Rhus* coastal scrub along Long Island Sound in Connecticut. Moreover, the specimens of *Eremocoris* from the cooler northern areas of New England were much more heat sensitive and more difficult to transport to the laboratory than those from warmer, more southern areas of New England. Such a variation was not seen in other cool-adapted rhyparochromines studied. The northern set of *Eremocoris* populations (*E. borealis*), was usually found in association with the lygaeid seedbugs *Scolopostethus diffidens* Horvath, *Antillocoris minutus* (Bergroth), *Plinthisus americanus* (Van Duzee) and sometimes *Scolopostethus thomsoni* Reuter in ground litter of cool Canadian Transitional Zone coniferous forests dominated by spruce (*Picea rubens* Sarg.) or hemlock (*Tsuga canadensis* (L.) Carr) and usually mixed with birches (*Betula papyrifera* Marsh, *B. lutea* Michx., *B. populifolia* Marsh) (Sweet 1964).

The more austral set of populations (*E. ferus*), was present in a larger variety of Carolinian Zone forest and shrub biotopes in southern New England but not in the relictual hemlock or spruce forests present. The insect was most common in open red maple-oak forests beneath the undershrubs *Vaccinium* spp. and *Viburnum* spp. where it occurred in association with the seedbugs *Ozophora picturata* Uhler, *Scolopostethus atlanticus* Horvath, *Drymus unius* (Say), and *Antillocoris minutus* (Bergroth). The southern *E. ferus* was also found in similar habitats along forest margins of eastern Texas and into central Texas under juniper breaks in sheltered locations along the edge of the Edwards Plateau. *E. ferus* fed on a broader range of host seeds (Sweet, 1964), but the propensity toward conifer seeds so marked among species of *Eremocoris* was still evident since the insects, despite being often present in deciduous woodlands, were frequently found feeding on the fallen seeds of *Juniperus* spp. and *Thuja occidentalis* L. Since both species would feed readily in the laboratory on the same variety of seeds, host preferences *per se* probably may play at most a subsidiary role in habitat selection.

Morphology.—A consequent morphological reexamination of the specimens of the two species thus recognized on reproductive and ecological evidence showed that they can be easily distinguished despite their close resemblance. In the northern species the hind tibia appears nearly nude, with the very short hairs being shorter than the length of the small moveable spurs present on the inner surface of the hind tibia (Fig. 1); the hairs on the body are also relatively more sparse and shorter, and on the abdominal venter the hairs are relatively long only on the terminal two sterna; the labium reaches, at most, the metasternum. In contrast the southern species has the hind tibia densely investitured with long erect hairs (Fig. 2) which are much longer than

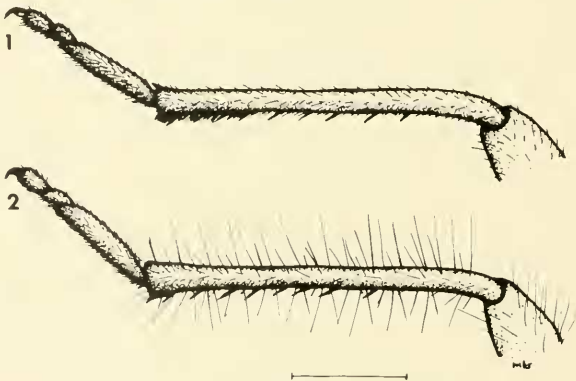


Fig. 1-2. Hind tibia showing investiture. Fig. 1.—*E. borealis* (Dallas), Fig. 2.—*E. ferus* (Say). Scale line equals 0.5mm.

the moveable spurs; the body hairs are relatively denser and longer and long hairs evenly cover nearly all of the abdominal venter; the labium reaches the abdomen. The tibial pilosity is the most reliable character. Increasingly toward the north and northwest a subbrachypterous form is present in *E. borealis*, which corresponds to the comparative habitat permanence of climax spruce taiga forest. Such wing polymorphisms are characteristic of many ground-living seedbugs of permanent habitats.

Eremocoris ferus (Say)

Since Thomas Say's specimens are no longer extant a neotype designation is required for *E. ferus*. Say (1831) collected in the area between Virginia and Indiana and studied collections from expeditions to the southern United States. It is very probable that Say had the southern population before him when he described *ferus*. I therefore hereby designate a neotype (USNM Type No. 73953) to fix the name *Eremocoris ferus* (Say) for the southern population. The type-specimen bears the data: Nelson Co., Va., June 30, 1924 (W. Robinson). A neotype designation is especially important in this case because of the mixed concept of *E. ferus* documented here. Moreover Say's description does not exactly agree with the concept of *E. ferus* as used by all subsequent authors. Say's description mentioned piceous hemelytra and the hemelytra of *E. ferus*, while relatively dark, are clearly bicolored. However, it surely would serve no meaningful purpose to change such a long accepted name for the common *Eremocoris* of the eastern United States. The present neotype designation would promote nomenclatural stability by fixing the name *Eremocoris ferus* (Say) for the eastern species discussed herein.

E. ferus (Say), as thus here understood has a Carolinian and Austroriparian Zone distribution extending from the Gulf of Mexico in the eastern United States north to lowland locations in New England with the northern records being from Boston, Massachusetts, Clarmont, New Hampshire, Storrs, Connecticut, and southern New York. The specimens so far seen from Illinois, Iowa and Indiana are all referable to *E. ferus* and appear to mark the northern limit of the distribution of the species in the midwest. I have seen no *E. ferus* from west of the 100° meridian. However, small relictual populations occur in sheltered cedarbreak habitats along the Balcones Escarpment of the Edwards Plateau of Texas and may extend west of the meridian.

Eremocoris borealis (Dallas)

E. borealis (Dallas, 1852) had been placed in synonymy with *E. ferus* (Say) by Uhler (1871). I was able to examine at the British Museum the lectotype selected by Scudder (1967) of *Rhyparochromus borealis* Dallas,

1852 which Scudder listed as a synonym of *E. ferus* (Say). The type-locality is Hudson's Bay which while it had a broader meaning before 1852 than at present, is still a northern location. The type-specimen was not in perfect condition, but it shows the requisite characters noted earlier and is clearly conspecific with the northern population of *Eremocoris* documented previously as distinct from *E. ferus*. I therefore raise *Eremocoris borealis* (Dallas, 1852: List Hem. B.M. 2: 565) (NEW STATUS) from synonymy with *Eremocoris ferus* (Say, 1831; Des. Het. Hem. N. Amer. p. 333).

Specimens which are attributable to *E. borealis* occur in the Canadian Zone from Anchorage, Alaska, Hudson's Bay (the type-locality), to Newfoundland and Labrador, and south in the east at high elevations along the Appalachians with specimens at hand from summits of Mt. LeConte, Tennessee (M.D. Leonard, X-10-26) and Black Mountain, N. Carolina. The southermost records available in the midwest are from Sparta, Wisconsin and Alger Co., Michigan (R.&K. Dreisbach). However, in the west, the species extends south through British Columbia and Alberta to Montana and Oregon. The specimens seen so far from Colorado, Wyoming, New Mexico and Arizona are neither *E. borealis* nor *E. ferus*.

It is clear from the study of specimens in various collections determined by H.G. Barber, the leading specialist on the Lygaeidae during the first half of this century, that Barber's concept of *Eremocoris ferus* in the western North America represents a complex of closely related species which includes *Eremocoris borealis*, *E. dimidiatus* Van Duzee, *E. obscurus* Van Duzee, and *E. canadensis* Walley, as well as several undescribed species, all of which I have studied. These western species, it may be noted, show parallel variations in the pilosity of the tibia, which led Barber to disregard this obvious difference between the northern and southern species of the eastern "*E. ferus*". In any case the western *Eremocoris* should be studied only in conjunction with the fauna of the eastern Palearctic. Indeed, Horvath (1883) noted the similarity of the Siberian *E. angusticollis* Jakovlev, 1881 to *E. ferus*. *E. angusticollis* could very well be a synonym of *E. borealis*, given the far northern taiga distribution of the cool-adapted *E. borealis*.

Sympatry — In the eastern part of its distribution, *E. borealis* narrowly overlaps the northern limits of the range of *E. ferus*. In the zone of sympatry in southern New England, *E. borealis* was found in cooler hemlock forest ravines; *E. ferus* in warmer deciduous edge habitats; the two were never found together in the same biotope. However, each species, *borealis* to the north, *ferus* to the south, were each found in a greater diversity of biotopes outside of than within the zone of sympatry. This suggests that within the zone of sympatry habitat displacement occurs: the northern species has the competitive advantage in cooler habitats; the southern species in warmer habitats.

In the zone of sympatry I could discern no morphological evidence in the specimens available of any intergradation or hybridization between the two species: the specimens formed distinctly separate series. Conversely, I saw no evidence of character displacement in the sense of Brown and Wilson (1956) in the color, size, pilosity, and labial length of specimens of the two species within the zone of sympatry.

The lack of character displacement may be interpreted as a result of the ecological displacement in the zone of sympatry. Since the two species were not found together in the same biotope, there may have been no direct competitive interactions to provide the selective pressures to create morphological character displacement, although ecophysiological character displacement may have occurred.

No one of the lines of evidence so far discussed would by itself demonstrate that two species are present. However, taken together, the reproductive, behavioral, ecological, morphological and distributional evidence, strongly supports the species distinction of *E. borealis* Dallas from *E. ferus* Say.

Key to the Species of *Eremocoris* of North America East of the 100^oth Meridian

1. Entire body and legs densely pilose with long erect hairs; hemelytra dark brown; fore femora armed beneath with two major spurs *E. setosis* Blatchley

At least femora, often hemelytra with at most short inconspicuous hairs; hemelytra at least in part pale; fore femora armed beneath with one major spur 2

2. Corium uniformly shining pale brown; nearly nude above; body strongly flattened in appearance, length of antennal segment 2 and length of anterior lobe of pronotum much greater than thickness of abdomen *E. depressus* Barber

Corium dull bicolored, anteriorly paler; at least scutellum pilose; body not flattened in appearance, length of antennal segment two and length of anterior lobe of pronotum less or equal to thickness of abdomen 3

3. Tibia pilose with hairs much longer than moveable spines (fig. 2) abdomen evenly pilose; labium attains abdomen *E. ferus* Say

Tibia sparsely pilose, hairs shorter than moveable spines (fig. 1), abdomen with long hairs only on posterior two segments; labium attains thoracic metasternum *E. borealis* Dallas

ACKNOWLEDGEMENTS

I am grateful to Dr. Richard Froeschner and Dr. Jon Herring for kindly permitting me to study the collection at the U.S. National Museum, for a loan of specimens and providing a USNM type number; to Dr. W.J. Knight and Dr. Black of the British Museum (Natural History), for permitting me to study the lectotype of *E. borealis* and for a loan of specimens. Part of the research was done while in tenure of a National Science

Foundation graduate fellowship at the University of Connecticut and a grant-in-aid from the National Science Foundation. Also, I thank Dr. Joseph Schaffner, Dr. John McEachran, and Dr. Jesse Cocke of Texas A&M University for critically reading the manuscript.

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